CLAIMS:

1-76 (canceled)

77. (Previously submitted) A method of drilling a bore in a formation, the method comprising:

supplying solid material impactors to a drill bit comprising a longitudinal axis; and

discharging the solid material impactors from the drill bit so that at least a portion of the solid material impactors contacts the formation, comprising:

discharging a first portion of the solid material impactors from the drill bit in a first direction, the first direction comprising:

a first directional component that is parallel to the longitudinal axis of the drill bit; and

a second directional component extending from, and perpendicular to, the first directional component; and

discharging a second portion of the solid material impactors from the drill bit in a second direction, the second direction comprising:

a third directional component that is parallel to the longitudinal axis of the drill bit; and

a fourth directional component extending from, and perpendicular to, the third directional component.

78. (Previously submitted) A method of drilling a bore in a formation, the method comprising:

supplying solid material impactors to a drill bit comprising a longitudinal axis;

discharging the solid material impactors from the drill bit so that at least a portion of the solid material impactors contacts the formation, comprising:

discharging a first portion of the solid material impactors from the drill bit in a first direction, the first direction comprising:

a first directional component that is parallel to the longitudinal axis of the drill bit; and

a second directional component extending from, and perpendicular to, the first directional component, wherein the second directional component is directed away from the longitudinal axis of the drill bit;

and

discharging a second portion of the solid material impactors from the drill bit in a second direction, the second direction comprising:

a third directional component that is parallel to the longitudinal axis of the drill bit; and

a fourth directional component extending from, and perpendicular to, the third directional component, wherein the fourth directional component is directed towards the longitudinal axis of the drill bit;

forming a rock ring within the bore in response to discharging the solid material impactors from the drill bit, comprising:

forming a generally radially-extending interior cavity in the bore, the interior cavity generally defining the inside diameter of the rock ring; and

forming a generally circumferentially-extending exterior cavity in the bore, the exterior cavity being generally concentric with the interior cavity, the exterior cavity generally defining the outside diameter of the rock ring;

and

fracturing the rock ring, comprising:

applying a side load on the rock ring;

wherein the drill bit comprises a junk slot; and

wherein forming the interior cavity comprises causing at least a portion of the solid material impactors to contact the bottom surface of the bore and rebound into the junk slot.

79. (Previously submitted) A method of drilling a bore in a formation, the method comprising:

supplying drilling fluid and solid material impactors to a drill bit;

discharging the drilling fluid and the solid material impactors from the drill bit so that at least a portion of the solid material impactors contacts the formation; and

forming a rock ring within the bore in response to discharging the drilling fluid and the solid material impactors from the drill bit.

80. (Previously submitted) A drill bit comprising a longitudinal center axis; a first nozzle oriented in a first direction, the first direction comprising a first directional component that is parallel to the longitudinal center axis, and a second directional component extending from, and generally perpendicular to, the first directional component; and a second nozzle oriented in a second direction, the second direction comprising a third directional component that is parallel to the longitudinal center axis, and a fourth directional component extending from, and generally perpendicular to, the third directional component.

81. (Previously submitted) A drill bit comprising a longitudinal center axis; a first nozzle oriented in a first direction, the first direction comprising a first directional component that is parallel to the longitudinal center axis, and a second directional component extending from, and generally perpendicular to, the first directional component; a second nozzle oriented in a second direction, the second direction comprising a third directional component that is parallel to the longitudinal center axis, and a fourth directional component extending from, and generally perpendicular to, the third directional component; first and second side arms, one of the first and second side arms comprising one of the first and second nozzles; and a center portion disposed between the first and second side arms; wherein each of the first and second nozzles is adapted to discharge drilling fluid and solid material impactors in a bore in a formation; wherein a rock ring is adapted to be at least partially formed within the bore in response to the discharge of the drilling fluid and the solid material impactors; wherein the center portion comprises a breaker surface adapted to break the rock ring; wherein the breaker surface comprises a conical surface adapted to apply a side load against the rock ring; wherein the center portion comprises the other of the first and second nozzles; wherein the conical surface tapers to the other of the first and second nozzles; and wherein each

of the first and second side arms comprises a bottom face, a side wall extending from the bottom face, one or more mechanical cutters interspersed along the bottom face, and one or more grooves formed in the bottom face.

82. (Previously submitted) A system for drilling a bore in a formation, the system comprising:

means for supplying solid material impactors to a drill bit comprising a longitudinal axis; and

means for discharging the solid material impactors from the drill bit so that at least a portion of the solid material impactors contacts the formation, comprising:

means for discharging a first portion of the solid material impactors from the drill bit in a first direction, the first direction comprising:

a first directional component that is parallel to the longitudinal axis of the drill bit; and

a second directional component extending from, and perpendicular to, the first directional component;

and

means for discharging a second portion of the solid material impactors from the drill bit in a second direction, the second direction comprising:

a third directional component that is parallel to the longitudinal axis of the drill bit; and

a fourth directional component extending from, and perpendicular to, the third directional component.

83. (Previously submitted) A system for drilling a bore in a formation, the system comprising:

means for supplying solid material impactors to a drill bit comprising a longitudinal axis;

means for discharging the solid material impactors from the drill bit so that at least a portion of the solid material impactors contacts the formation, comprising:

means for discharging a first portion of the solid material impactors from the drill bit in a first direction, the first direction comprising:

a first directional component that is parallel to the longitudinal axis of the drill bit; and

a second directional component extending from, and perpendicular to, the first directional component, wherein the second directional component is directed away from the longitudinal axis of the drill bit;

and

means for discharging a second portion of the solid material impactors from the drill bit in a second direction, the second direction comprising:

a third directional component that is parallel to the longitudinal axis of the drill bit; and

a fourth directional component extending from, and perpendicular to, the third directional component, wherein the fourth directional component is directed towards the longitudinal axis of the drill bit;

means for forming a rock ring within the bore in response to discharging the solid material impactors from the drill bit, comprising:

means for forming a generally radially-extending interior cavity in the bore, the interior cavity generally defining the inside diameter of the rock ring; and

means for forming a generally circumferentially-extending exterior cavity in the bore, the exterior cavity being generally concentric with the interior cavity, the exterior cavity generally defining the outside diameter of the rock ring;

and

means for fracturing the rock ring, comprising:

means for applying a side load on the rock ring;

wherein the drill bit comprises a junk slot; and

wherein means for forming the interior cavity comprises means for causing at least a portion of the solid material impactors to contact the bottom surface of the bore and rebound into the junk slot.

84. (Previously submitted) A system for drilling a bore in a formation, the system comprising:

means for supplying drilling fluid and solid material impactors to a drill bit;

means for discharging the drilling fluid and the solid material impactors from the drill bit so that at least a portion of the solid material impactors contacts the formation; and

means for forming a rock ring within the bore in response to discharging the drilling fluid and the solid material impactors from the drill bit.

85. (Previously submitted) A method of drilling a bore in a formation, the method comprising:

supplying drilling fluid and solid material impactors to a drill bit comprising a longitudinal axis, comprising coupling a drill string to the drill bit, the drill string comprising a passage through which the drilling fluid is supplied to the drill bit, wherein an annulus is defined between the drill string and the inner wall of the bore;

discharging the drilling fluid and the solid material impactors from the drill bit so that at least a portion of the solid material impactors contacts the formation, wherein formation cuttings are formed in response to discharging the drilling fluid and the solid material impactors from the drill bit, wherein discharging the drilling fluid and the solid material impactors from the drill bit comprises:

discharging a first portion of the solid material impactors from the drill bit in a first direction, the first direction comprising:

a first directional component that is parallel to the longitudinal axis of the drill bit; and

a second directional component extending from, and perpendicular to, the first directional component, wherein the second directional component is directed away from the longitudinal axis of the drill bit;

and

discharging a second portion of the solid material impactors from the drill bit in a second direction, the second direction comprising:

a third directional component that is parallel to the longitudinal axis of the drill bit; and

a fourth directional component extending from, and perpendicular to, the third directional component, wherein the fourth directional component is directed towards the longitudinal axis of the drill bit;

forming a rock ring within the bore, comprising:

at least one of:

discharging the first portion of the solid material impactors from the drill bit in the first direction; and

discharging the second portion of the solid material impactors from the drill bit in the second direction;

forming a generally radially-extending interior cavity in the bore, the interior cavity generally defining the inside diameter of the rock ring; and

forming a generally circumferentially-extending exterior cavity in the bore, the exterior cavity being generally concentric with the interior cavity, the exterior cavity generally defining the outside diameter of the rock ring;

fracturing the rock ring, comprising:

applying a side load on the rock ring;

breaking down large portions of the rock ring; and

abrading and delivering load to the rock ring;

circulating at least a portion of the solid material impactors through the annulus;

abrading the bottom surface of the bore;

forming the final diameter of the bore, comprising at least one of:

trimming the bore; and

refining the inner wall of the bore;

stabilizing and reducing vibration in the drill bit; and

permitting the drilling fluid, at least a portion of the cuttings, and at least a portion of the solid material impactors to flow freely from the bottom surface of the bore and to the annulus;

wherein the drill bit comprises first and second junk slots;

wherein forming the interior cavity comprises:

causing at least a portion of the solid material impactors to contact the bottom surface of the bore and rebound into the first junk slot; and

causing at least another portion of the solid material impactors to contact the bottom surface of the bore and rebound into the first junk slot;

wherein forming the exterior cavity further comprises:

causing at least a portion of the solid material impactors to contact the bottom surface of the bore and rebound into the second junk slot;

wherein the exterior cavity comprises generally circumferentially-extending inner and outer portions, the inner and outer portions being generally concentric;

wherein forming the exterior cavity comprises:

cutting the formation at the outer portion of the exterior cavity; and

cutting the formation at the inner portion of the exterior cavity;

wherein residual pieces of the rock ring are formed in response to fracturing the rock ring;

wherein the method further comprises washing at least a portion of the residual pieces of the rock ring away from the drill bit through the annulus;

wherein broken portions of the rock ring are formed in response to fracturing the rock ring;

wherein the method further comprises:

permitting the broken portions of the rock ring to flow from the bottom surface of the bore to the first and second junk slots; and

guiding the cuttings and the drilling fluid to the annulus via the first and second junk slots;

wherein the drill bit comprises first, second and third nozzles; and

wherein discharging the drilling fluid and the solid material impactors from the drill bit comprises:

feeding at least a portion of the drilling fluid and at least a portion of the solid material impactors to the first nozzle;

feeding at least a portion of the drilling fluid and at least a portion of the solid material impactors to the second nozzle; and

feeding at least a portion of the drilling fluid and at least a portion of the solid material impactors to the third nozzle.

86. (Previously submitted) A drill bit adapted to discharge drilling fluid and solid material impactors in a bore in a formation, the drill bit comprising:

a longitudinal center axis;

a first nozzle oriented in a first direction, the first direction comprising:

a first directional component that is parallel to the longitudinal center axis, and

a second directional component extending from, and generally perpendicular to, the first directional component, wherein the second directional component is directed away from the longitudinal center axis; and

a second nozzle oriented in a second direction, the second direction comprising:

a third directional component that is parallel to the longitudinal center axis, and

a fourth directional component extending from, and generally perpendicular to, the third directional component, wherein the fourth directional component is directed towards the longitudinal center axis;

a third nozzle adapted to discharge a third portion of the solid material impactors in the bore;

first, second and third cavities fluidicly coupled to the first, second and third nozzles, respectively, wherein the cavities are adapted to be fluidicly coupled to a common plenum;

first and second side arms, each of the first and second side arms comprising a radially interior portion and a radially exterior portion, the first side arm comprising the third nozzle and one of the first and second nozzles;

a center portion disposed between the first and second side arms, the center portion comprising the other of the first and second nozzles;

a first junk slot extending between the first and second arms; and

a second junk slot extending between the first and second arms;

wherein the center portion is disposed between the first and second junk slots;

wherein a rock ring is adapted to be at least partially formed within the bore in response to the discharge of the drilling fluid and the solid material impactors;

wherein the center portion comprises a breaker surface adapted to break the rock ring;

wherein the breaker surface comprises a conical surface adapted to apply a side load against the rock ring;

wherein the conical surface tapers to the other of the first and second nozzles;

wherein the breaker surface comprises one or more mechanical cutters adapted to abrade and load the rock ring;

wherein the second direction is configured so that at least a portion of the solid material impactors adapted to be discharged from the second nozzle are adapted to contact the formation and rebound into the first junk slot;

wherein the first direction is configured so that at least a portion of the solid material impactors adapted to be discharged from the first nozzle are adapted to contact the formation and rebound into the second junk slot;

wherein the breaker surface comprises one or more recesses adapted to permit broken portions of the rock ring to flow from the bottom surface of the bore to the first junk slot; and

wherein each of the first and second side arms comprises:

a bottom face;

a side wall extending from the bottom face;

one or more mechanical cutters interspersed along the bottom face and adapted to break down large portions of the rock ring and abrade the bottom surface of the bore;

one or more grooves formed in the bottom face;

one or more other mechanical cutters interspersed along the side wall, wherein the one or more other mechanical cutters comprise one or more gauge cutters adapted to form the final diameter of the bore, and wherein at least one of the gauge cutters comprises a cutting face adapted to contact the inner wall of the bore; and

one or more gauge bearing surfaces interspersed along the side wall and adopted to reduce vibration generated during the discharge of the drilling fluid and the solid material impactors.

87. (Previously submitted) A system for drilling a bore in a formation, the system comprising:

means for supplying drilling fluid and solid material impactors to a drill bit comprising a longitudinal axis, comprising means for coupling a drill string to the drill bit, the drill string comprising a passage through which the drilling fluid is supplied to the drill bit, wherein an annulus is defined between the drill string and the inner wall of the bore;

means for discharging the drilling fluid and the solid material impactors from the drill bit so that at least a portion of the solid material impactors contacts the formation, wherein formation cuttings are formed in response to discharging the drilling fluid and the solid material impactors from the drill bit, wherein means for discharging the drilling fluid and the solid material impactors from the drill bit comprises:

means for discharging a first portion of the solid material impactors from the drill bit in a first direction, the first direction comprising:

a first directional component that is parallel to the longitudinal axis of the drill bit; and

a second directional component extending from, and perpendicular to, the first directional component, wherein the second directional component is directed away from the longitudinal axis of the drill bit;

and

means for discharging a second portion of the solid material impactors from the drill bit in a second direction, the second direction comprising:

a third directional component that is parallel to the longitudinal axis of the drill bit; and

a fourth directional component extending from, and perpendicular to, the third directional component, wherein the fourth directional component is directed towards the longitudinal axis of the drill bit;

means for forming a rock ring within the bore, comprising:

at least one of:

means for discharging the first portion of the solid material impactors from the drill bit in the first direction; and

means for discharging the second portion of the solid material impactors from the drill bit in the second direction;

means for forming a generally radially-extending interior cavity in the bore, the interior cavity generally defining the inside diameter of the rock ring; and

means for forming a generally circumferentially-extending exterior cavity in the bore, the exterior cavity being generally concentric with the interior cavity, the exterior cavity generally defining the outside diameter of the rock ring;

means for fracturing the rock ring, comprising:

means for applying a side load on the rock ring;

means for breaking down large portions of the rock ring; and

means for abrading and delivering load to the rock ring;

means for circulating at least a portion of the solid material impactors through the annulus;

means for abrading the bottom surface of the bore;

means for forming the final diameter of the bore, comprising at least one of:

means for trimming the bore; and

means for refining the inner wall of the bore;

means for stabilizing and reducing vibration in the drill bit; and

means for permitting the drilling fluid, at least a portion of the cuttings, and at least a portion of the solid material impactors to flow freely from the bottom surface of the bore and to the annulus;

wherein the drill bit comprises first and second junk slots;

wherein means for forming the interior cavity comprises:

means for causing at least a portion of the solid material impactors to contact the bottom surface of the bore and rebound into the first junk slot; and

means for causing at least another portion of the solid material impactors to contact the bottom surface of the bore and rebound into the first junk slot;

wherein means for forming the exterior cavity further comprises:

means for causing at least a portion of the solid material impactors to contact the bottom surface of the bore and rebound into the second junk slot;

wherein the exterior cavity comprises generally circumferentially-extending inner and outer portions, the inner and outer portions being generally concentric;

wherein means for forming the exterior cavity comprises:

means for cutting the formation at the outer portion of the exterior cavity; and

means for cutting the formation at the inner portion of the exterior cavity;

wherein residual pieces of the rock ring are formed in response to fracturing the rock ring;

wherein the system further comprises means for washing at least a portion of the residual pieces of the rock ring away from the drill bit through the annulus;

wherein broken portions of the rock ring are formed in response to fracturing the rock ring;

wherein the system further comprises:

means for permitting the broken portions of the rock ring to flow from the bottom surface of the bore to the first and second junk slots; and

means for guiding the cuttings and the drilling fluid to the annulus via the first and second junk slots;

wherein the drill bit comprises first, second and third nozzles; and

wherein means for discharging the drilling fluid and the solid material impactors from the drill bit comprises:

means for feeding at least a portion of the drilling fluid and at least a portion of the solid material impactors to the first nozzle;

means for feeding at least a portion of the drilling fluid and at least a portion of the solid material impactors to the second nozzle; and

means for feeding at least a portion of the drilling fluid and at least a portion of the solid material impactors to the third nozzle.